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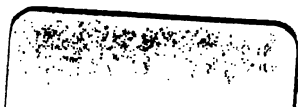
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Aug 26-29

ECONOMICS OF INTER- URBAN RAILWAYS

BY

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FIRST EDITION



McGRAW-HILL BOOK COMPANY, Inc.

239 WEST 39TH STREET, NEW YORK

6 BOUVERIE STREET, LONDON, E. C.

1914

Transportation
Library

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THE MAPLE PRESS, YORK, PA

PREFACE

Notwithstanding the fact that there are over twenty thousand miles of electric suburban and electric interurban railway now in operation in the United States, of which the operating records are available through the medium of the various State Commission reports, and otherwise, there is little data of actual and proven information so compiled as to be useful to the great number of persons, residing in almost every community, who are promoting, or are encouraging the promotion of, an electric interurban railway.

The fact that, in almost every instance, electric interurban railways have proven to be popular utilities, has caused much development in the construction of such properties, irrespective of the possible or probable economic result incident to their operation, and, in consequence, many of the undertakings have been unprofitable. This condition, which is parallel with that of the early days of steam railroad construction, has caused the investing

public to regard electric interurban railway securities with some suspicion.

In view of these existing conditions, it is believed that there is a need for a résumé of the actual economic results from the operation of the existing electric interurban railways, for the purpose of enabling the layman to comprehend the fundamental conditions essential to an economically successful road, and the investor to discriminate between fundamentally good or bad electric interurban railway securities.

L. E. F.

ST. LOUIS, MO.,
December, 1913.

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ECONOMICS OF INTER- URBAN RAILWAYS

CHAPTER I

INCEPTION AND DEVELOPMENT OF ELECTRIC TRACTION

THE first authentic record of a well-conceived plan to obtain tractive power by means of electricity dates from the early '50's, and between that time and the year 1880, when Edison and Field became interested, many attempts were made to work out a feasible scheme, but all of them lacked commercial value.

The real birth of the electrically operated railway, as a practical method of transportation, was in 1888, when Frank J. Sprague equipped a short electric railway line in Richmond, Va., which, though crude from the standard of to-day, was successful. Previous to this, at expositions and elsewhere, electric

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railways had been built for exhibition and experimentation.

The practicability of the electric railway being quickly demonstrated, there became an immediate demand for this means of traction, and by the year 1890 there had been about two hundred electric railway companies, with a trackage of about 1200 miles, organized in the United States. In England and Germany the work was taken up, and some important installations were undertaken. During the next ten years far-reaching improvements were made in the equipment, and by the year 1902 there were over seven hundred electric railways in operation in this country, with an aggregate total of about 22,000 miles of track—a truly remarkable growth.

THE ELECTRIC SUBURBAN RAILWAY

From the electric railway, operating over and along the streets of a city, it was an easy step to the electric suburban railway, which originated in the simple extension of a city line to the suburbs of that city. It was speedily recognized that in the electric suburban railway

DEVELOPMENT OF ELECTRIC TRACTION 3

was the solution of the vexing problem of how to remedy the ever-increasing congestion of population within a narrow zone around the commercial center of each of the large cities. With the development of the electric suburban railway came the outward development of the growth of the cities for residential purposes, bringing benefits to those working in the cities so great and far-reaching as to be incalculable.

Step by step with the increasing importance of electric traction, improvements in equipment and operation were made, the inventor never lagging behind the constructor.

THE ELECTRIC INTERURBAN RAILWAY

The next step, the development of the electric interurban railway, was of much greater magnitude than that of the simple evolution of the suburban railway. The problem of the transmission of power over long distances had to be solved, and there were many other questions which the pioneer had to work out. The great minds of the master electricians soon solved the power problem and gave to the world the rotary converter, improved transformers,

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and the transmission of high potential alternating current to substations.

The earliest attempt at electric interurban railway construction was about the year 1900, and it was not until the year 1902 that the development became general.

The pioneer builders of electric interurban railways were confronted with the problem of deciding whether the tracks of the railway should be built on private right-of-way, or along the pikes and highways. To build the tracks on private right-of-way, across open country of broken topography, to build bridges over rivers and streams, and in fact, to do all of those things in track construction that the steam railroads had done, appeared to them to necessitate the expenditure of an overwhelming amount of money, and they, unfortunately for operating efficiency, adopted the alternative of utilizing the pikes and highways. The early interurban railway was, therefore, in reality an extension of the suburban railway, made possible by the then recent developments in power transmission.

The pioneer lines having demonstrated the feasibility and practicability of the project, the

demand for interurban railways became general, and later builders began to utilize the private right-of-way instead of the pikes and highways for their tracks, and from that time the electric interurban railway became the popular utility it now is.

When carrying passengers between towns it became necessary to carry their baggage, and, from this beginning, the handling of express matter, United States mail, milk and broken freight, was a natural sequence in evolution.

In solving the transportation problems which became more abstruse as the mileage of individual roads increased, the electric interurban railway followed the practice of the steam railroads, and adopted train schedules and dispatching systems, and rules and devices for the safety of its operation. As the traffic increased, trains of cars, under multiple control, were operated, and in some instances dining and sleeping cars were added to the passenger equipment.

The electric interurban railway policy has always been aggressive in its reach for business, and after acquiring success in the passenger, express and broken freight field, the large earn-

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ings to be derived from the handling of bulk freight, and the interchange of traffic with other roads, was sufficient incentive for some of the larger electric railways to enter the field as general freight carriers. This development has been of recent date, and at the present time is restricted to a few of the largest electric railway systems, and these systems are being operated on the same basis as the steam railroads, and are doing identically the same carrying business, including the interchange of traffic and equipment with them.

The growth of the electric suburban and electric interurban railways has been wonderful, as since the year 1902 there has been constructed, and placed in operation, over twenty thousand miles of track. The development has been especially active in the states of New York, Pennsylvania, Massachusetts, Ohio, Indiana, Illinois and California, as in these states more than thirteen thousand miles, out of the total of about twenty thousand miles, have been constructed.

CHAPTER II

CLASSIFICATIONS AND DEFINITIONS

THE diversity in the scope of operation of the various electric railways, popularly called electric interurban railways, renders an analysis of their earnings and expenditures, as a whole, unproductive of tangible results. It is therefore necessary to define first what will herein be considered as an electric interurban railway, and second the terms used in the subsequent analysis of the fundamental principles governing their operating revenues and expenses, and cost of construction.

CLASSIFICATION OF ELECTRIC RAILWAYS

Electric railways may be divided into four general classes: Urban, Suburban, Interurban and Commercial.

ELECTRIC INTERURBAN RAILWAY

An electrically operated railway connecting two or more independent distant communities

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and organized and operated to carry passengers, baggage, United States mail, express and freight in broken shipments. This railway is distinct from an urban or suburban railway, in that the latter serves only the inhabitants of a city, or of a city and its suburbs, for the purpose of carrying passengers and their ordinary hand baggage. It is also distinct from a commercial railway in that it does not do, or undertake to do, a general bulk and interchange freight business.

CLASSIFICATION OF TYPE OF ELECTRIC INTERURBAN RAILWAYS, AND ALSO OF TERRITORIES SERVED

In considering the economic results obtained by the various electric interurban railways now operating, it is necessary to classify the types of roads, and also of territories served, into two general classes—the normal and the abnormal.

NORMAL ELECTRIC INTERURBAN RAILWAY—GENERAL CHARACTERISTICS OF

Entrances into cities, towns and villages served by franchises over city streets.

Private right-of-way outside of cities and villages.

Roadbed constructed with reasonable curves and gradients.

Track laid with 70- or 80-lb. rail and standard ties, 2-ft. centers.

Power house of ample size and constructed for economical operation.

Car equipment ample and of modern type.

Well constructed primary distributing system, and overhead, or third-rail, secondary distributing system.

Substantially hourly service, with local trains operating alternately with limited trains. Limited schedule practically equal to the local schedule of the competing steam railway lines.

One or more broken package freight movements each way per day.

Rate of fare approximately two cents per mile, with a reduction of from 10 to 25 per cent. when round-trip tickets are purchased.

**ABNORMAL ELECTRIC INTERURBAN RAILWAY—
GENERAL CHARACTERISTICS OF**

No entrance into principal cities served.

Constructed on highways.

Roadbed of such curves and gradients as to

10 ECONOMICS OF INTERURBAN RAILWAYS

constitute barriers to the procurement of a reasonable portion of the available business.

Track construction such as to constitute a barrier to procurement of a reasonable portion of the available business.

Power house inadequate, and unsuited to generate current at reasonable cost.

Car equipment obsolete, insufficient and uncomfortable.

Insufficient primary and secondary distributing systems to maintain reasonable voltage for movement of cars.

Two hourly, or less frequent, service.


No broken package freight movements.

NORMAL TERRITORY—GENERAL CHARACTERISTICS OF

A territory made up of cities, towns and villages which are supported by varied agricultural, manufacturing or mining industries, and which are free from the fluctuating influences of summer, health or amusement resorts, or other similar traffic-creating centers, and which are also free from serious business depressions due to local industrial conditions.

ABNORMAL TERRITORY—GENERAL CHARACTERISTICS OF

A territory made up of cities, towns, and villages, one or more of which is a large pleasure-drawing center, or is in a state of industrial decay due to local conditions, or where the principal industries are of such a nature as to be subject to long periods of business depression, or to prolonged strikes.



CLASSIFICATION OF POPULATION SERVED

The population served by an electric inter-urban railway, other than its tributary farming population, may be divided into three general classes, as follows:

Primary Terminal Population.

Secondary Terminal Population.

Intermediate Town and Village Population.

PRIMARY TERMINAL POPULATION

The population of the principal city into which the railway operates. In other words, the population of that city which is of the greatest commercial importance in the sense

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that it is a metropolis for the greater portion of the territory served.

SECONDARY TERMINAL POPULATION

The population of the other important terminals, distinct from the principal terminal, which are also of such commercial importance as to attract business from a considerable portion of the territory served, but not to the same extent as the principal terminal.

INTERMEDIATE TOWN AND VILLAGE POPULATION

The population of cities, towns and villages, served by the line, beyond and between (when there are both primary and secondary terminals), but not including the primary and secondary terminals.

* * * * *

The tributary farming population residing within the territory served by the line is excluded from consideration. In a normal farming territory the value of this population, from the view-point of its traffic productiveness, is reflected in the size and character of the towns and villages which constitute the intermediate

town and village population. There has been much importance attached to the density of the farming population, and it has been quite customary to approximate its aggregate within arbitrary distances of the line, varying from 1 mile to 4 miles. Aside from such estimates being extremely crude, there are such a variety of local conditions influencing the extent of the zone limiting the tributary population that no uniform principle for considering its value on that basis can be established. On the other hand, the towns and villages constituting the intermediate town and village population will reflect all of the characteristics of the farming community that contribute to their support. If such a territory has fertile lands, it will support a greater number of townspeople; if the roads are good in a farming community, the sphere of the commercial activities of the town will be increased and it will therefore have a larger population; and so, likewise, will progressive types of farmers have a bearing on the town in which they trade. Even though a town or village may be largely developed because of manufacturing or mining industries, yet to the extent that the town or village has

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been supported by the tributary farming population it will reflect with reasonable accuracy the value of the farming population as to its traffic productiveness.

CLASSIFICATION OF TRAFFIC SOURCES

The traffic created by the population served by an electric interurban railway will be consequent to the following general movements:

Source I:

- a. The intercommunication of the population of the primary terminal and the intermediate population served.
- b. The intercommunication of the population of the intermediate centers only.

Source II:

- c. The intercommunication of the population of the secondary terminals and the intermediate population served.
- d. The intercommunication of the population of the primary terminal and the population of the secondary terminals.
- e. The intercommunication of the population of the secondary terminals alone (if more than one).

It will be noted that the traffic created by "a" and "b," of Source I, is consequent to the existence of the primary terminal and the intermediate population, while the traffic created by "c," "d" and "e," of Source II, is consequent to the existence of the secondary terminal population.

CHAPTER III

OPERATING REVENUE

THE Interstate Commerce Commission, in accordance with Section 20 of an Act to Regulate Commerce, has prescribed a classification of the operating revenues of electric railways as follows:

General accounts:

- I. Revenue from transportation.
- II. Revenue from operations other than transportation.

Primary accounts:

- I. Revenue from transportation:
 - (1) Passenger revenue.
 - (2) Baggage revenue.
 - (3) Parlor, chair and special car revenue.
 - (4) Mail revenue.
 - (5) Express revenue.
 - (6) Milk revenue.

- (7) Freight revenue.
- (8) Switching revenue.
- (9) Miscellaneous transportation revenue.

II. Revenue from operations other than transportation:

- (10) Station and car privileges.
- (11) Parcel-room receipts.
- (12) Storage.
- (13) Car service.
- (14) Telegraph and telephone service.
- (15) Rents of tracks and terminals.
- (16) Rents of equipment.
- (17) Rents of buildings and other property.
- (18) Power.
- (19) Miscellaneous.

RELATION BETWEEN "REVENUE FROM TRANSPORTATION" AND "REVENUE FROM OTHER THAN TRANSPORTATION"

Very few of the existing electric interurban railways earn an appreciable amount of revenue from operations other than transportation, except through the sale of power. It is quite usual for an electric interurban railway to serve a territory from which considerable revenue

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can be earned by the sale of power, but as the development of this item of earning is very dependent on the management of the property, and therefore not general, it will be eliminated from further consideration.

RELATION BETWEEN "PASSENGER REVENUE" AND "OTHER THAN PASSENGER REVENUE," POWER SALES ELIMINATED

The one section of the general accounts, revenue from operations other than transportation, being thus considered a negligible quantity in this discussion, there is left the other main heading of revenue from transportation. The most natural question arising in this connection is in regard to the relation of the passenger revenue to the other revenue, such as that from baggage, freight, express, etc. The following table on this point has been prepared for ten cases indiscriminately selected from normal roads serving normal territories:

TABLE I.—SHOWING "PASSENGER REVENUE" AND "OTHER THAN PASSENGER REVENUE" FOR TEN TYPICAL SELECTED CASES

Case	Passenger revenue	Express, freight and other non-passenger revenue	Total gross revenue	Percentage express and freight to gross revenue
(1).....	\$405,979	\$5,720	\$411,698	1.384
(2).....	1,210,170	77,992	1,939,521	5.597
(3).....	570,632	35,923	606,555	5.922
(4).....	823,346	13,977	858,135	1.618
(5).....	286,185	28,212	355,077	9.855
(6).....	872,566	86,467	959,033	9.016
(7).....	930,600	137,618	1,068,219	12.882
(8).....	346,205	59,685	405,890	14.704
(9).....	498,994	121,574	620,568	19.580
(10).....	197,405	37,111	234,516	15.821
Average...	\$614,208	\$60,428	\$691,321	8.732
Average on 243,229 miles of steam road in 1911:				
	631,340,776	2,155,338,840	2,786,679,616	77.344

From the typical cases above tabulated it is apparent that the predominating item in the revenue account of electric interurban railways is passenger revenue. In the present stage of development of such lines, with their limited operations in the express and freight fields, all the other than passenger revenue items comprising revenue from transportation are of such little consequence compared with passenger revenue

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that the entire group of revenue from transportation items will be considered together and will constitute gross operating revenue throughout this discussion.

POSSIBILITY OF GENERAL FREIGHT BUSINESS FOR ELECTRIC INTERURBAN RAILWAYS

The electric interurban railway, as we have defined it, maintains only an express and broken package freight service, yet in the mind of the public there is a good opportunity for it to take up a general freight service. In view of this misconception of the true sphere of the electric interurban railway and the exaggerated ideas of the possibilities for extensions of electric railway activities along such a line it will be well to point out briefly at this point the fundamental elements that are essential to a road which engages in a general freight traffic.

General freight traffic involves the movement of commodities in carload lots in reasonable numbers, with reasonable frequency, from the producer to the consumer, independently or jointly with other carriers by interchange agreement. To make such a movement independ-

ently, both the producer and consumer must be served by the line. On the other hand, to carry on such a movement jointly with other carriers involves interchange relations with these carriers in the making of which electric interurban railways are handicapped by the fact that they are mostly parasites of the pioneer steam railroads in the sense that they serve the same territories by parallel lines and compete to a certain degree for the same traffic. Even though the interchange relations with other carriers exist, still the superior facilities of the steam railroads make it difficult for the electric interurban railways to procure any material portion of the available business.

The point may be raised that electric interurban railways serving large cities qualify for a general freight traffic in the sense that they have both the producers and consumers of bulk freight in the territory served by them. This is true, but as electric interurban roads generally enter their terminals over the city streets, the producers and consumers of bulk freight can be served by them only through the medium of transfer wagons. The steam railroads, on the contrary, almost invariably serve the

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industries over their own switch tracks and thereby place the electric interurban railway at a tremendous disadvantage.

On the assumption, however, that an electric interurban railway has a lack of destructive steam road competition and such liberal franchises as will enable it to engage in the general freight traffic, still the question of the proper construction and equipment to handle such traffic is not a small one. The movement of trains of freight cars involves a far more elaborate power system and diversity of equipment than does the movement of trains of cars of one or two units handling merely passenger, express and light freight traffic. The additional cost of providing the necessary power appliances and freight equipment, together with the handicaps encountered in procuring any great volume of bulk freight traffic, constitutes a barrier against engaging in such traffic which very few of the electric interurban railways have attempted to surmount. Some electric railways have developed into commercial railways by engaging in the bulk freight traffic, but they are not procuring such economical results as will lend much encouragement to the promo-

tion of new lines on the theory that the freight traffic revenue can be made a material part of the total gross revenue.

RELATION EXISTING BETWEEN OPERATING
REVENUE AND POPULATION SERVED
ONLY FROM SOURCE I

In tracing out the relation between the population served and operating revenue, we shall discuss first the case of electric interurban railways having traffic movements arising from Source I, or from a primary terminal and intermediate town and village population but no secondary terminal. The following table has been compiled from cases indiscriminately selected from normal roads of this class serving normal territories:

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TABLE II.—SHOWING STATISTICS OF GROSS OPERATING
REVENUE OF TYPICAL LINES WITH A "PRIMARY"
TERMINAL AND INTERMEDIATE POPULATION,
BUT NO "SECONDARY" TERMINAL

Case	Location	Miles of track	Primary terminal popula- tion	Inter- mediate town and village popula- tion	Gross oper- ating revenue
(1)	Iowa.....	76	86,368	12,071	\$140,120
(2)	Michigan.....	16	13,194	5,811	64,839
(3)	Missouri.....	22	248,341	3,633	88,889
(4)	New Jersey....	18	44,461	5,506	92,146
(5)	New Jersey....	15	8,336	8,173	59,317
(6)	New Jersey....	17	13,298	11,223	99,346
(7)	New York.....	17.6	11,504	4,040	75,023
(8)	New York.....	16.5	37,176	5,458	64,958
(9)	New York.....	12.5	6,420	8,651	77,215
(10)	West Virginia..	19.3	41,641	4,589	105,394
(11)	Connecticut....	13	13,502	7,882	96,869
(12)	Connecticut....	50	133,605	9,517	52,379
(13)	Connecticut....	11	19,659	6,213	46,732
(14)	Oklahoma.....	17	13,000	6,312	66,750
(15)	Illinois.....	11	14,548	4,055	41,776
(16)	Illinois.....	19	6,090	3,191	25,516
(17)	Illinois.....	12.5	22,789	2,700	29,585
(18)	Illinois.....	14	11,456	5,884	54,300
(19)	Illinois.....	7	8,102	3,926	29,175
(20)	Indiana.....	32	24,005	13,053	111,048
(21)	Indiana.....	23	63,933	4,671	70,618
(22)	Indiana.....	31	19,359	9,701	99,200
(23)	Indiana.....	25	69,647	8,300	109,851
(24)	Ohio.....	25.5	18,266	10,330	121,109
(25)	Ohio.....	24	5,222	2,227	29,000
(26)	Ohio.....	53	364,403	10,068	104,000

TABLE II (Continued)

Case	Location	Miles of track	Primary terminal popula- tion	Inter- mediate town and village popula- tion	Gross oper- ating revenue
(27)	Ohio.....	38	20,387	14,986	\$142,000
(28)	Ohio.....	20	46,921	10,136	72,984
(29)	Ohio.....	18.5	9,076	1,855	20,800
(30)	Ohio.....	51	116,577	10,034	106,656
(31)	Pennsylvania...	19	12,623	4,788	46,376
(32)	Pennsylvania...	36	5,749	8,073	91,347
(33)	Pennsylvania...	20	1,556,231	10,223	108,186
(34)	Pennsylvania...	31	87,411	5,088	58,430
(35)	Pennsylvania...	10	5,474	1,640	13,703
(36)	Massachusetts .	20	6,740	11,794	58,435

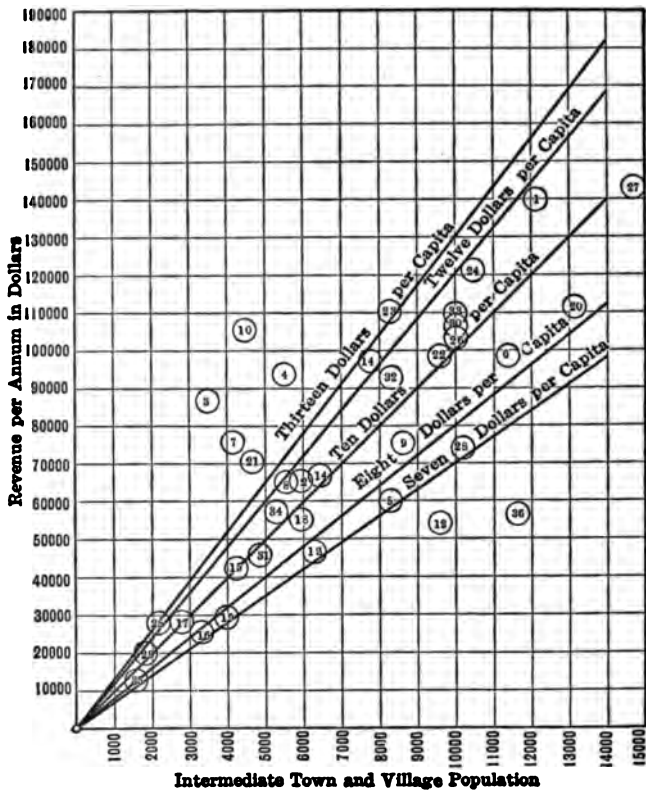
The above statistics indicate:

(1) That the length of the road and the amount of the operating revenue have no direct relation with each other from which analytical deductions can be drawn;

(2) That the size of the primary terminal has no material influence upon the amount of operating revenue; and

(3) That approximately the operating revenue varies directly with the aggregate of the intermediate town and village population. This is graphically set forth by the chart on page 26.

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By reference to this chart it will be noted that out of the thirty-six roads tabulated twenty-one are within the limits of the lines representing an earning per capita of intermediate town and village population of between \$8 and \$12, and that all but seven of these cases are within the limits of the lines representing an earning per capita of town and village population of between \$7 and \$13. It will furthermore be noticed that the relation between the average earnings of the thirty-six cases cited and the town and village population is approximately represented by the line indicating \$10 per capita of intermediate town and village population.

Attention is again directed to the fact that the above deductions are made from the operations of normal roads serving normal territory, and therefore they will be very misleading if applied to abnormal lines or abnormal territories. It is not intended, however, to imply that a normal electric interurban railway serving a normal territory that is productive of revenue from only Source I will earn \$7, or \$10, or \$13 per capita of intermediate town and village population; indeed, the fact that these

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limits are sometimes exceeded is clearly indicated in the chart. It is clearly shown, however, that the earnings, in all probability, will vary between \$7 and \$13 per capita of intermediate town and village population and that the general average is approximately \$10 per capita of that population.

STATISTICS OF REVENUE OF LINES PRODUCTIVE OF EARNINGS FROM SOURCES I AND II

Table II and the discussion of it have served to show the relation between population and revenue for electric interurban railways deriving earnings from Source I only. We shall now consider a combination of Source I and Source II and statistics assembled for railways having a primary terminal, one or more secondary terminals and an intermediate town and village population. The cases in Table III have also been indiscriminately selected from normal roads serving normal territories.

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TABLE III.—SHOWING STATISTICS OF TYPICAL LINES
WITH A PRIMARY TERMINAL, ONE OR MORE
SECONDARY TERMINALS AND AN INTER-
MEDIATE TOWN AND VILLAGE
POPULATION

Case	Miles of track	Primary terminal popula- tion	Second- ary terminal popula- tion	Inter- mediate town and village popula- tion	Gross operat- ing revenue
(1) . . .	28.5	20,367	8,696	2,723	\$84,522
(2) . . .	32	25,976	7,353	2,150	118,000
(3) . . .	130	2,185,283	55,783	35,400	1,210,170
(4) . . .	93	233,650	20,081	26,879	428,456
(5) . . .	40	19,359	17,010	2,700	152,535
(6) . . .	320	233,650	62,650	112,097	1,899,706
(7) . . .	65	63,933	37,655	7,642	257,868
(8) . . .	39	12,687	10,480	5,439	135,748
(9) . . .	41	223,928	6,305	4,625	123,863
(10) . . .	32	8,981	13,650	7,364	306,962
(11) . . .	82	31,297	11,080	1,695	91,219
(12) . . .	199.5	423,715	31,770	14,711	858,135
(13) . . .	67	74,419	9,491	12,443	207,150
(14) . . .	36.4	50,217	24,026	4,892	222,110
(15) . . .	26	18,266	5,501	6,582	118,292
(16) . . .	222	560,663	49,651	74,146	1,068,219
(17) . . .	150	560,663	228,194	36,023	1,009,638
(18) . . .	122	704,428	51,678	39,006	664,607
(19) . . .	95	31,140	38,189	13,163	420,690
(20) . . .	40	66,950	25,768	2,477	235,665
(21) . . .	40	51,678	31,140	4,853	247,663

It will be remembered that the general conclusion derived from Table II was that the

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approximate general average of operating revenue for lines deriving their traffic only from Source I was \$10 per capita of intermediate town and village population. Using this approximate figure as a basis for an estimate of earnings from Source I in Table III, we can by subtraction arrive at the portion of earnings attributable to Source II in Table III. The last column in Table IV, therefore, shows the per capita revenue of secondary terminal population. The average distance between terminals is also included

The statistics in Table IV indicate:

(1) That the length of road has in this case, as in the previous case, no relative bearing (from which any conclusions can be drawn) on the amount of operating revenue from Source II;

(2) That the operating revenue from Source II is not governed by the population of the primary terminal; and

(3) That the relations existing between revenue from Source I and the intermediate town and village population, heretofore shown, do not exist between the revenue from Source II and the intermediate town and village population.

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TABLE IV.—SHOWING STATISTICS OF ROADS LISTED IN
TABLE III, BUT WITH REVENUES DIVIDED INTO
THOSE FROM SOURCE I AND THOSE
FROM SOURCE II

Case	Miles of track	Average distance between terminals	Total gross revenue	Estimated revenue Source I	Estimated revenue Source II	Revenue from Source II per capita of secondary terminal population
(1)...	28.5	28.5	\$84,522	\$27,230	\$57,292	\$6.60
(2)...	32	32	118,000	21,500	86,500	12.00
(3)...	130	32	1,210,170	354,000	856,170	15.00
(4)...	93	60	428,456	268,790	159,666	8.00
(5)...	40	24	152,535	27,000	125,535	7.35
(6)...	320	50	1,899,706	1,120,970	768,736	12.30
(7)...	65	65	257,868	76,420	175,448	4.70
(8)...	39	39	135,748	54,390	81,358	8.00
(9)...	41	40	123,863	46,250	79,613	12.30
(10)...	32	32	306,962	73,640	232,320	17.00
(11)...	82	22	91,219	16,950	74,269	6.70
(12)...	199.5	40	858,135	147,110	711,025	22.40
(13)...	67	30	207,150	124,430	82,720	8.70
(14)...	36.4	15	222,110	48,920	171,190	7.12
(15)...	26	26	118,292	65,820	53,532	9.70
(16)...	222	50	1,068,219	741,460	326,759	6.55
(17)...	150	80	1,009,638	360,230	649,408	2.85
(18)...	122	100	664,607	390,006	274,601	5.30
(19)...	95	50	420,690	131,630	289,060	7.60
(20)...	40	40	235,665	24,770	210,895	8.20
(21)...	40	40	247,663	48,530	199,133	6.40

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The reason why the same relationship does not exist between the intermediate town and village population and the revenue derived from Source I and Source II, respectively, is obvious. A road operating between a primary terminal and a secondary terminal, through an intermediate town and village population, will not obtain materially different results in so far as they relate to the earnings contributed by the population of the intermediate towns and villages than a road serving merely a primary terminal and an intermediate town and village population. The reason for this is that the average inhabitant of the intermediate towns and villages, if but one terminal is available to him, will direct his attention to that terminal, whereas if two terminals are available he will travel sometimes to one and sometimes to the other. Hence the sum total of the revenue derived from his patronage is approximately the same in each instance; consequently as the revenue from Source II per capita of intermediate town and village population increases, the revenue from Source I per capita of intermediate town and village population decreases, and the approximate per



capita average of \$10 previously obtained is affected accordingly.

On the other hand, the table discloses the fact that the revenue from Source II per capita of secondary terminal population does not vary so widely as it seems to do from a casual examination of the table. As the earnings from Source II are essentially created by the existence of one or more secondary terminals, it is reasonable that there should exist some approximate relation between the amount of this revenue and the entire population of the secondary terminal, or secondary terminals, served. If the average distance between terminals is taken into consideration, as well as the character of the terminals, these relations may be readily brought out by a study of Table IV, and we may sum them up in the form of two general postulates:

(1) The greater the average distance between terminals the less the revenue from Source II per capita of secondary terminal population.

That this should be the case is logical from the fact that electric interurban railways paralleling steam railroads will procure for short

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distances, say 40 miles or less, practically all of the passenger traffic, owing to the frequency of service and the convenience of its operation over the city streets into the heart of the city. For distances greater than 40 miles, the presumed greater hazard, discomfort or loss of running time of the electric lines as compared with the steam lines results in the proportion of the traffic which the electric lines procure being gradually diminished as the distance increases.

(2) The second postulate deduced from Table IV has to do with the drawing facilities of the terminals rather than their distances apart, and it is to the effect that the earnings from Source II per capita of secondary terminal population depend largely upon the causes for intercommunication between the various terminals.

It is clear that two comparatively small terminals in close proximity, one a county seat and the other a manufacturing center, will have far greater intercommunication than if both terminals are county seats. Again there will be greater intercommunication per capita in the case of a very large city connected with a nearby substantially smaller city than in the

case of one comparatively large terminal, sufficient unto itself, connected by an electric line with another similar large terminal.

GENERAL CONCLUSIONS CONCERNING REVENUE FROM SOURCE II

The above postulates are fundamental generalizations that are easily discernible. But it is very evident, however, that any attempt to set forth an approximate concrete relation between the revenue from Source II and the population of the secondary terminal is an extremely difficult undertaking. Nevertheless, the foregoing statistics and discussions do indicate the following general tendencies governing revenues from Source II:

(1) That where the secondary terminal is removed from the principal terminal a distance of 40 miles or less the revenue from Source II will vary between \$6 and \$20 per capita of that secondary terminal population, depending upon the causes for intercommunication and the efficiency of the service rendered; and

(2) That when the secondary terminal is removed from the principal terminal a dis-

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tance greater than 40 miles the revenue from Source II per capita of that secondary terminal population will be diminished practically 10 per cent. for each 10 miles of increased distance.

OTHER STATISTICS CONCERNING REVENUE FROM OPERATION, SHOWING SLIGHTNESS OF RELATION BETWEEN REVENUE AND CAR MILES OPERATED

The above tables and discussions have afforded a glimpse of the relation between the population served and the operating revenue of electric interurban railways. It was stated as a conclusion to Table II and Table IV that the length of the road and the amount of operating revenue bear no direct relation to each other from which any analytical deduction can be drawn. Inasmuch as it is customary, however, to use the unit of car-mile revenue in considering the revenue of railroads, it may be well to present here Table V, showing the revenue per car-mile for twenty typical electric interurban railways.

This table, with its utter lack of uniformity

TABLE V.—SHOWING REVENUE PER CAR MILE FOR
TWENTY TYPICAL INTERURBAN ELECTRIC RAILWAYS

Case	Miles of track	Gross revenue	Car miles operated	Revenue per car mile
(1).....	41	\$123,863	639,290	\$0.1954
(2).....	17	66,750	313,498	0.2122
(3).....	20	108,186	572,977	0.1886
(4).....	25	141,085	474,564	0.2975
(5).....	32	107,278	341,542	0.3111
(6).....	51	133,240	558,428	0.2385
(7).....	38	149,304	648,728	0.2301
(8).....	46	230,142	1,052,089	0.2166
(9).....	23.7	70,618	191,674	0.3684
(10).....	40	145,689	638,987	0.2284
(11).....	320	1,899,706	5,852,994	0.3081
(12).....	101	546,980	2,294,714	0.2383
(13).....	62	405,890	1,307,924	0.3103
(14).....	122	620,568	2,146,413	0.2889
(15).....	40	234,516	818,425	0.2865
(16).....	32	101,993	341,542	0.2986
(17).....	222	1,068,219	3,818,028	0.2965
(18).....	30	67,416	367,460	0.1985
(19).....	170	999,274	3,276,608	0.3083
(20).....	45	355,469	923,705	0.3826

in revenue per car mile, amply illustrates the futility of attempting to estimate revenue on this unit basis for electric interurban railways. The revenue per car mile will naturally be dependent upon the frequency of service, which, on the other hand, depends upon the judgment of the management and also upon

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the demands of local conditions. Furthermore, the question of multiple-unit operation enters into the subject of average earnings per car mile, as does also the question as to whether the traffic is balanced, that is to say, the extent of the equality of movement in opposite directions.

COMPARISON OF ELECTRIC INTERURBAN AND STEAM RAILWAY REVENUES

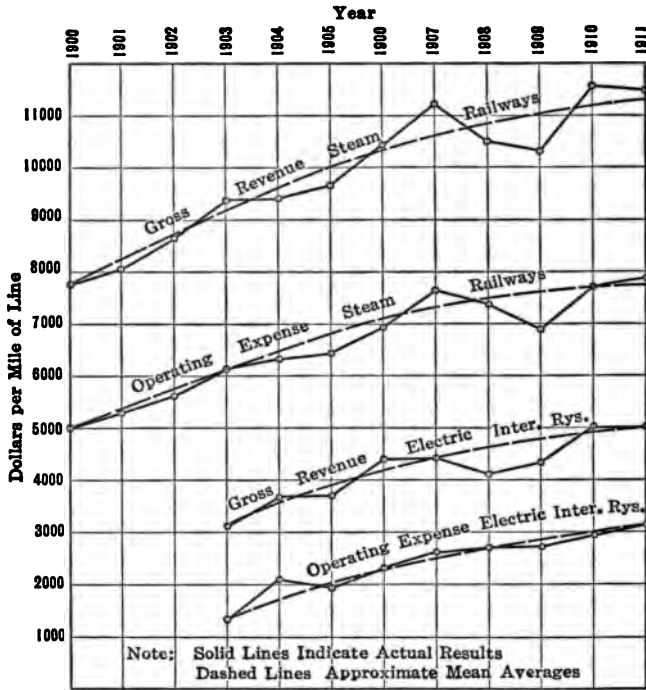
The average gross revenue per mile of line on 243,229 miles of steam railroads in 1911, according to the statistics of the Interstate Commerce Commission, was \$11,589, of which \$2708 was derived from passenger traffic. Similar statistics for electric interurban railways are not available, but from the records of the typical cases listed in Table V, which may be said to be representative of all roads qualifying as electric interurban railways under the definition hereinbefore given, the average gross revenue per mile of line is \$5130.

While these figures are interesting from the view-point of disclosing the relative earning power of steam railroads and electric interurban railways, they are of little impor-

tance on account of the different conditions prevailing in the two fields. The electric interurban railways, deriving substantially all of their revenue from passenger traffic sources, are limited to sections of dense population where large passenger traffic exists. Steam roads, deriving a large percentage of their revenue from freight sources, are not limited to such restricted areas and have been located more especially for the primary purpose of developing freight traffic. Therefore, that the earnings of the electric interurban railways should be considerably higher than the passenger revenue of steam roads and considerably less than the gross revenue of steam roads is but a logical result.

The chart on the next page graphically discloses the growth of the average revenue and operating expense per mile of line per year of the steam railroads as compared to that of the electric interurban railways. The statistics of the steam lines are again taken from the report of the Interstate Commerce Commission, while those of the electric interurban railways have been gathered from the operating statements of a number of typical lines.

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From this chart it is obvious that the growth of revenue per mile of line on electric interurban railways is not keeping pace with that of steam railroads. It appears also that the operating expense per mile of line on the steam railroads has not increased as rapidly as the revenue on these lines. This has resulted in a gradual increase in the net revenue per mile of line derived from steam railroad operation. The growth of operating expense on electric interurban railways, however, has substantially kept pace with the growth of revenue per mile of line, with the result that the increase of net revenue per mile of line on electric railways has been very little and was less in 1911 than in 1910.

One of the characteristics of electric interurban railways, the mileage of which has not been extended from time to time, is that the available revenue was quickly developed and that at the end of this period the revenue has increased at a very low rate. This is not especially revealed by the chart on page 40, owing to the influence which the constantly increasing mileage has had on the revenue of the cases used in preparing the chart.

CONCLUSION

The generally accepted, and doubtless the best, method of determining the probable revenue of a projected line is to apply to determinable units of population of the projected line the known unit results obtained by operating roads whose type of construction and method of operation and the general characteristics of whose territory are in all respects similar to and comparable with homologous attributes of the projected road. In using already existing roads to determine the feasibility of a projected line, however, care must be exercised in determining the equality of conditions and in making corrections to compensate for differences productive of change in the revenue results. In view of previous discussion as to the relation between operating revenue and the population of the territory served, it is obvious, too, that careful consideration must be given to the distribution of the population as well as to the amount thereof.

The greatest point of interest in the contemplated establishment of an electric interurban railway is, of course, the probable revenue.

The final determination of this should in general be left to those who have expert knowledge of such matters and whose judgment and discriminating discernment of the valuation of varying elements affecting revenue is of the highest character. It is possible, however, for the layman by an intelligent application of the rules governing the approximate relations existing between the revenue and the population served, as heretofore established, to determine, within reasonable limits, the probable revenue that normal interurban railways can obtain in normal territories, and in this way to determine approximately whether the projected line is fundamentally good or fundamentally bad from the point of view of the investor.

CHAPTER IV

OPERATING EXPENSE

THE classification of operating expenses of electric railways, as prescribed by the Interstate Commerce Commission in Section 20 of an act to regulate commerce, is as follows:

General accounts:

- I. Way and structures.
- II. Equipment.
- III. Traffic.
- IV. Conducting transportation.
- V. General and miscellaneous.

Each of these headings is subdivided into many primary accounts, but for the sake of clearness each group of subdivisions will be taken up separately in the order of the general headings given above.

WAY AND STRUCTURES

The first general account, way and structures, is detailed by the Interstate Commerce Commission in the following manner:

Primary accounts:

- (1) Superintendence of way and structures.

Maintenance of way:

Maintenance of roadway and track:

- (2) Ballast.
 - (3) Ties.
 - (4) Rails.
 - (5) Rail fastenings and joints.
 - (6) Special work.
 - (7) Underground construction.
 - (8) Roadway and track labor.
 - (9) Paving.
 - (10) Miscellaneous roadway and track expenses.
 - (11) Cleaning and sanding tracks.
 - (12) Removal of snow, ice and sand.
- Other maintenance of way:
- (13) Tunnels.
 - (14) Elevated structures and foundations.
 - (15) Bridges, trestles and culverts.
 - (16) Crossings, fences, cattle guards and signs.
 - (17) Signal and interlocking systems.
 - (18) Telephone and telegraph systems.
 - (19) Other miscellaneous way expenses.

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Maintenance of electric lines:

- (20) Poles and fixtures.
- (21) Underground conduits.
- (22) Transmission system.
- (23) Distribution system.
- (24) Miscellaneous electric line expenses.
- (25) Buildings and structures.
- (26) Depreciation of way and structures.
- (27) Other operations—Dr.
- (28) Other operations—Cr.

STATISTICS OF ACTUAL OPERATING EXPENSE FOR WAY AND STRUCTURES ON TYPICAL ELECTRIC INTERURBAN RAILWAYS

Before several of these primary accounts are taken up in detail it may be interesting to ascertain whether any consistency exists in the operating expense for way and structures on various electric interurban lines. Table I has been compiled at random from typical roads now in operation:

TABLE I.—SHOWING STATISTICS OF ACTUAL OPERATING EXPENSE FOR WAY AND STRUCTURES ON TEN TYPICAL ELECTRIC INTERURBAN RAILWAYS

Case	Miles of track	Expense per mile of track per annum
(1).....	52	\$999
(2).....	128	558
(3).....	83	794
(4).....	180	430
(5).....	45	774
(6).....	170	474
(7).....	222	519
(8).....	67	760
(9).....	122	426
(10).....	46	661
Average in above cases.....		555
Average on 243,229 miles of steam road in 1911, per mile of line. ¹		1,519

The above statistics clearly bring out two points. In the first place, such a great variation in operating expense for way and structures as is shown by the typical roads cited is quite conclusive proof that we need look no farther for consistency in this item of expense. But the second point, one more

¹ The statistics for the steam roads in this and the following tables are per mile of line and not per mile of track. In the comparisons it is therefore necessary to make due allowance for such portions of the steam railway mileage as are equipped with more than one main track.

surprising, is the very great comparative difference between the average expense per mile of track per annum on electric interurban railways and the similar expense on steam roads. While it is obvious that a steam-operated road, moving a great volume of heavy traffic, requires a greater expenditure of money to maintain its way and structures than does an electric road with its lighter equipment and a greatly reduced number of car-mile movements, still it does not seem logical that there should be so great a difference. The fact is that electric interurban railways are undoubtedly making less outlay than necessary for way and structures rather than that the railroads are making more than is necessary. The average age of the existing electric interurban lines is only about five or six years, and a sufficiently high standard of maintenance under such a condition has not been generally adopted. It is quite probable that even the minimum expenditure for way and structures on normal electric interurban railways under average conditions is considerably higher than the average amount in Table I.

MOST IMPORTANT PRIMARY ACCOUNTS UNDER WAY AND STRUCTURES

If it is true, as intimated in the preceding paragraph, that electric interurban railways on the average are paying less than is advisable for way and structures, a closer examination into what ought to be the limits of expenditure under such a heading for average normal conditions would be of value at this point.

The various primary accounts outlined by the Interstate Commerce Commission under the general account, way and structures, do not all rank equally in importance so far as the aggregate amount of this account is concerned. The expenses of superintendence and depreciation are less than that of maintenance, and the items constituting the bulk of the total maintenance cost on average lines are as follows: ties; roadway and track labor; bridges, trestles and culverts, and sundry items constituting maintenance of electric lines.

It is obviously impossible to lay down the exact amounts for these several expenses, but as a result of careful study a statement of figures can be made that undoubtedly approximate

the average for normal electric interurban railways serving normal territories.

The average line has 2600 ties per mile and the average life of these ties is ten years. Thus an average of 260 ties per mile of track per year must be renewed, which at an average of 70 cents per tie is equivalent to \$182 per mile of track per year.

On an estimate, under average conditions, of two men and a foreman to a section of 6 miles, the least cost of roadway and track labor per mile of track per year is approximately \$250.

The item of maintenance of bridges, trestles and culverts will naturally vary a great deal on different roads but will average at least \$50 per mile of track per year.

Sundry items constituting maintenance of electric lines, including also the maintenance of telegraph and telephone lines, will average at least \$100 per mile of track per year.

Although the allowance for depreciation is less than that for maintenance, still it forms an item of considerable size. If we proceed on the assumption that twenty years' use of rail will reduce its value from the cost of new

rail to the cost of relayer, then one-twentieth of \$10 per ton will represent the approximate amount to be set aside to cover the depreciation of the rail. The average electric road uses rail weighing approximately 100 tons to the mile, which then would be equivalent to a yearly depreciation of \$50 per mile for rail only. If this is added to the probable depreciation of bridges and other structures, at least \$100 per mile of track per year will be required for this expense.

The sum of the above-estimated amounts is \$682 per mile of track per year, which, as we said before, constitutes the bulk of the total cost of way and structures on the average electric interurban line. An estimate of \$150 per mile of track for all other items not specifically enumerated above, including superintendence, is a very low minimum, which makes the least total cost logical and reasonable for way and structures \$832 per mile of track per year.

The result of our examination, therefore, has indicated the fact that the average minimum expenditure for way and structures on normal electric interurban railways, approximately set at \$832 per mile of track per year,

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is considerably above the average of \$555 for the typical lines cited in Table I. Moreover, it is only about one-half of the similar expense on steam railroads. This estimate, be it understood, is by no means radical. It would seem, therefore, that, on the basis of the information in Table I and the above approximate figures, definite conclusions might be drawn in regard to the outlay for way and structures on electric interurban lines, and the two that appear to sum up the case best are these:

(1) That electric interurban railways are not now bearing the burden of operating costs under the heading of way and structures that they will ultimately have to bear; and

(2) That the actual expense of way and structures on the average electric road will vary between \$800 and \$1000 per mile of track per year.

EQUIPMENT

The first general account for electric interurban railways under the Interstate Commerce Commission system, that of way and structures, having been disposed of, we may next

turn our attention to the one following, or the equipment account. This is subdivided as follows:

Primary accounts:

- (29) Superintendence of equipment.
 - Maintenance of power equipment:
- (30) Power-plant equipment.
- (31) Substation equipment.
 - Maintenance of cars and locomotives:
- (32) Passenger and combination cars.
- (33) Freight, express and mail cars.
- (34) Locomotives.
- (35) Service cars.
 - Maintenance of electric equipment of cars and locomotives:
- (36) Electric equipment of cars.
- (37) Electric equipment of locomotives.
 - Miscellaneous equipment expenses:
- (38) Shop machinery and tools.
- (39) Shop expenses.
- (40) Horses and vehicles.
- (41) Other miscellaneous equipment expenses:
 - (42) Depreciation of equipment.
 - (43) Other operations—Dr.
 - (44) Other operations—Cr.

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STATISTICS OF ACTUAL OPERATING EXPENSE FOR EQUIPMENT ON TYPICAL ELECTRIC INTERURBAN RAILWAYS

The statistics in Table II have been prepared from ten cases indiscriminately selected from normal electric interurban railways serving normal territories:

TABLE II.—GIVING ACTUAL OPERATING EXPENSE FOR
EQUIPMENT ON TEN TYPICAL ELECTRIC
INTERURBAN RAILWAYS

Case	Car miles operated per mile of track per year	Expense per car mile	Expense per mile of track per year
(1).....	33,756	\$0.0210	\$699
(2).....	41,066	0.0193	790
(3).....	25,478	0.0224	567
(4).....	22,149	0.0233	471
(5).....	20,527	0.0232	476
(6).....	19,274	0.0209	402
(7).....	15,856	0.0225	357
(8).....	21,095	0.0203	428
(9).....	18,593	0.0202	379
(10).....	20,460	0.0285	582
Average.....	22,490	\$0.0212	\$482
Average on 243,229 miles of steam road in 1911, per mile of line	.....	.....	1,775

The statistics of the expense covered by the equipment account of steam roads, as indicated by the above table, are in no wise comparable to those of electric interurban railways, and the comparison serves only to show the approximate relation existing between them.

The statistics in regard to electric interurban lines indicate that 2 cents per car mile is the minimum expense for equipment and 3 cents per car mile is the maximum. The expense per car mile will, of course, depend largely on the number of car mile movements. The ordinary electric interurban railway, rendering an hourly passenger service for the greater part of nineteen hours per day, with its additional movements in the way of trail cars, express, mail, freight and work cars, will operate between 15,000 and 20,000 car miles per mile of track per year. The result for roads rendering half-hourly service is approximately double that.

MAINTENANCE AND DEPRECIATION OF EQUIPMENT

The expenses for maintenance of way and structures and for maintenance of equipment

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on electric interurban railways vary considerably in amount. The maximum expense of maintaining equipment in operative condition is reached in a year or two after the equipment is put in service. Therefore well-managed lines are now bearing approximately the maximum burden of expense of maintaining equipment, while on the other hand, as stated before, a high standard of maintenance of way and structures has not been widely adopted.

This is not the only difference that exists between the two general accounts, however, for the amount per mile of track that must be set aside for depreciation of equipment exceeds that necessary for depreciation of way and structures. The question of adequate depreciation for equipment, however, is at the present time receiving more serious consideration. In general a passenger motor car, costing approximately \$10,000, will operate on an average about 50,000 miles a year. On the assumption that such a motor car after operating twenty years will have depreciated to one-third of its original value, then the annual depreciation will be approximately 3 1/2 per cent., or \$350 per year, which is equivalent to

seven-tenths of a cent per car mile. When this amount of depreciation is considered in connection with the minimum expense of 2 cents per car mile derived from Table II, it is evident that we are safe in drawing this conclusion—that the average expense in connection with equipment, if proper provision is made for depreciation, is approximately 3 cents per car mile, which is equivalent in the case of the basic hourly service to from \$450 to \$600 per mile of track per year.

TRAFFIC

The schedule of primary accounts under the third general heading of traffic is as follows:

Traffic expenses:

- (45) Superintendence and solicitation.
- (46) Advertising.
- (47) Miscellaneous traffic expenses.

STATISTICS FOR ACTUAL OPERATING EXPENSE FOR TRAFFIC ON TYPICAL ELECTRIC INTERURBAN RAILWAYS

Table III has been compiled from ten cases indiscriminately selected from normal electric interurban roads serving normal territories:

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TABLE III.—SHOWING ACTUAL OPERATING EXPENSE FOR
TRAFFIC ON TYPICAL ELECTRIC INTERURBAN
RAILWAYS

Case	Cost per mile of track per annum
(1).....	\$10
(2).....	46
(3).....	38
(4).....	64
(5).....	53
(6).....	61
(7).....	20
(8).....	89
(9).....	114
(10).....	94
Average.....	48
Average on 243,229 miles of steam road in 1911, per mile of line.....	234

The above statistics indicate that as yet electric interurban railways have not employed extensive organizations for the purpose of developing traffic. As the electric interurban railway develops into a commercial electric railway the traffic expense will be increased. The question of the proper extent of such an organization, from an economic point of view, depends much on local conditions, but, speaking generally, we may say that electric interurban railways should maintain more extensive

departments for the development of traffic than is now the practice.

In so far as it is possible to make deductions from the limited figures available in the traffic expense field, it seems that an electric interurban railway should expend from \$50 to \$150 per mile of track per year for the purpose of maintaining an active traffic organization to secure the available business as rapidly as possible.

CONDUCTING TRANSPORTATION

Continuing our analysis of the general accounts prescribed by the Interstate Commerce Commission for electric interurban railroads, we find that the fourth heading, that of conducting transportation is subdivided as follows:

Primary accounts:

(48) Superintendence of transportation.

GROUP I—POWER

(49) Power-plant employees.

(50) Substation employees.

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- (51) Fuel for power.
 - Other power supplies and expenses:
- (52) Water for power.
- (53) Lubricants for power.
- (54) Miscellaneous power-plant supplies and expenses.
- (55) Substation supplies and expenses.
- (56) Power purchased.
- (57) Power exchanged—balance.
- (58) Other operations—Dr.
- (59) Other operations—Cr.

GROUP II—OPERATION OF CARS

- Conductors, motormen and trainmen:
- (60) Passenger conductors, motormen and trainmen.
- (61) Freight and express conductors, motormen and trainmen.
- Miscellaneous transportation expenses:
- (62) Miscellaneous car service employees.
- (63) Miscellaneous car service expenses.
- Station employees and expenses:
- (64) Station employees.
- (65) Station expenses.

Carhouse employees and expenses:

- (66) Carhouse employees.
- (67) Carhouse expenses.
 - Signal, interlocking, telephone and telegraph systems:
- (68) Operation of signal and interlocking systems.
- (69) Operation of telephone and telegraph systems.
- (70) Express and freight collections and delivery.
- (71) Loss and damage.
- (72) Other transportation expenses.

STATISTICS OF ACTUAL OPERATING EXPENSE
FOR CONDUCTING TRANSPORTATION ON
TYPICAL ELECTRIC INTERURBAN
RAILWAYS

Table IV, given herewith, has been compiled from statistics obtained from ten representative electric interurban railways on the subject of expense per car mile and per mile of track per year for conducting transportation:

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TABLE IV.—GIVING STATISTICS OF ACTUAL OPERATING
EXPENSE FOR CONDUCTING TRANSPORTATION
ON TYPICAL INTERURBAN RAILWAYS

Case	Car miles operated per mile of track per year	Expense per car mile	Expense per mile of track per year
(1).....	33,756	\$0.0855	\$2,672
(2).....	41,060	0.0793	3,242
(3).....	25,478	0.1011	2,564
(4).....	22,149	0.0895	1,978
(5).....	20,527	0.0841	1,702
(6).....	19,274	0.0821	1,562
(7).....	15,856	0.1057	1,676
(8).....	21,095	0.0893	1,884
(9).....	18,593	0.1059	1,977
(10).....	20,460	0.0845	1,727
Average.....	22,490	\$0.0907	\$2,049
Average on 243,229 miles of steam road in 1911, per mile of line.	.....	.....	3,887

The results per car mile shown by the above roads are surprisingly uniform. The expense per mile of track per year will naturally vary directly with the frequency of the service.

PRINCIPAL PRIMARY ACCOUNTS FOR CONDUCT- ING TRANSPORTATION

The principal items making up the aggregate expense of conducting transportation

are: First—All of Group I, or that composed of the various power expenses. This expense, with the improvement of the art of generating electricity and with the increase in the volume of power generated, has a downward tendency. Second—The wages of employees engaged in conducting transportation. This expense has a slow upward tendency, due to the gradual increase in wages, which possibly compensates the downward tendency in the expense of the power group. The higher expense for wages on steam roads is due to the fact that one of the greatest savings effected by electric operation over steam operation is in the lower wage paid the train crews of electric trains as compared with train crews on steam trains. A motorman or conductor of an electric train gets approximately 1 1/2 cents per train mile operated, while an engineer or conductor of a steam train gets about 3 cents per train mile operated.

The character of these principal items and, indeed, all the expenses of conducting transportation, and the fact that there is no depreciation charge, indicate that the operating lines are now carrying the approximate maximum

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burdens under this heading. It is evident from the statistics given above that the average expense of electric interurban lines for conducting transportation is about 9 cents a car mile, which is equivalent to from \$1350 to \$1800 per mile of track per year on roads maintaining a basic hourly schedule.

GENERAL AND MISCELLANEOUS

The last of the general headings designated by the Interstate Commerce Commission for electric interurban railway accounts is that of general and miscellaneous, the primary accounts under which are as follows:

Primary accounts:

General expenses.

Salaries and expenses of general officers and general office clerks.

(73) Salaries and expenses of general officers.

(74) Salaries and expenses of general office clerks.

(75) General office supplies and expenses.

(76) Law expenses.

(77) Relief department expenses.

- (78) Pensions.
- (79) Miscellaneous general expenses.
- (80) Other operations—Dr.
- (81) Other operations—Cr.
- (82) Injuries and damages.
- (83) Insurance.
- (84) Stationery and printing.
Store and stable expenses.
- (85) Store expenses.
- (86) Stable expenses.
- (87) Rent of tracks and terminals.
- (88) Rent of equipment.

STATISTICS OF ACTUAL OPERATING EXPENSE
FOR GENERAL AND MISCELLANEOUS ITEMS
ON TYPICAL ELECTRIC INTERURBAN
RAILWAYS

The expenses per car mile and per mile of track for general and miscellaneous items for ten typical electric interurban railways are as follows:

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TABLE V.—GIVING STATISTICS OF ACTUAL GENERAL AND MISCELLANEOUS OPERATING EXPENSES ON TEN ELECTRIC INTERURBAN RAILWAYS

Case	Car miles operated	Expense per car mile	Expense per mile of track per year
(1).....	33,756	0.0169	\$561
(2).....	41,066	0.0461	1,893
(3).....	25,478	0.0403	1,022
(4).....	22,149	0.0172	379
(5).....	20,527	0.0479	887
(6).....	19,274	0.0392	750
(7).....	15,856	0.0199	315
(8).....	21,095	0.0268	565
(9).....	18,593	0.0393	718
(10).....	20,460	0.0286	585
Average.....	22,490	0.0321	\$730
Average on 243,229 miles of steam road in 1911, per mile of line	.....	.....	287

Reference to the individual items of the schedule of general and miscellaneous expenses will disclose the cause for much of the variation in this branch of operating expense in the above cases. The item of rental of tracks and terminals must of necessity introduce a very indeterminate quantity, and the other items are also readily seen to be subject to large variations. It will be noted that this

general account is the only one under operating expense in which the electric roads exceed the steam roads. This condition is probably due to the fact that this account is divisible into much greater mileages on steam roads than on electric roads.

While no fixed costs can be determined as applicable to all electric interurban railways, yet from the above statistics it can be seen that an allowance of from 3 cents to 4 cents per car mile for general and miscellaneous operating expenses is adequate for the average electric road, which is equivalent to from \$450 to \$800 per mile of track per year for roads operating on a basis hourly schedule and using the tracks of other roads in entering terminals.

TOTAL OPERATING EXPENSE

We have now taken up one by one the five general operating expense accounts, ways and structures, equipment, traffic, conducting transportation and general and miscellaneous, and by means of an analysis of the primary accounts involved we have arrived at the decisive factors in the allowances necessary under these headings for a normal electric

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interurban railway serving normal territory. It would now be well to assemble these various results to obtain if possible a general deduction in regard to the total operating expense of such a line. The complete summary of the statistics for the cases already cited is given in Table VI:

TABLE VI.—SHOWING A SUMMARY OF THE ACTUAL
GENERAL OPERATING EXPENSES FOR THE TEN
TYPICAL CASES BEFORE CITED

Per mile of track per year								
Case	Way and structures	Equipment	Traffic	Conducting transportation	General and miscellaneous	Total	Car miles operated	Total expense per car mile
(1)	\$999	\$699	\$10	\$2,672	\$561	\$4,950	33,756	\$0.1495
(2)	558	790	46	3,242	1,893	6,521	41,066	0.1595
(3)	792	567	38	2,564	1,022	4,984	25,478	0.1965
(4)	430	471	64	1,978	379	3,322	22,149	0.1514
(5)	774	476	53	1,702	887	3,892	20,527	0.1892
(6)	474	402	61	1,562	750	3,249	19,274	0.1696
(7)	519	357	20	1,676	315	2,887	15,856	0.1821
(8)	760	428	89	1,884	565	3,726	21,095	0.1766
(9)	426	379	114	1,977	718	3,614	18,593	0.1949
(10)	661	582	94	1,727	585	3,649	20,460	0.1784
Average.	\$562	\$482	\$48	\$2,049	\$730	\$3,872	.....	\$0.1702
Average on 243,229 miles of steam road in 1911, per mile of line						\$7,957		

The above statistics indicate that the approximate average expense per mile of track per year for electric operation is one-half that for steam railroad operation. These statistics also show that the average expense of operating the roads represented by the above cases, under the system of accounting now in vogue, is approximately 17 cents per car mile.

GENERAL CONCLUSIONS CONCERNING THE COST OF OPERATING ELECTRIC INTERURBAN RAILWAYS

From the preceding discussion of the operating expense of existing electric interurban railways and the discussion of elements of the operating expense not now properly taken into account, the general summary of the approximate operating expense of a normal electric interurban railway shown in Table VII has been prepared:

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TABLE VII.—SHOWING THE ESTIMATED OPERATING EXPENSE UNDER THE GENERAL OPERATING EXPENSE ACCOUNTS FOR NORMAL ELECTRIC INTERURBAN RAILWAYS

Operating account	Expense per mile of track per year	
Way and structures.....	\$800	\$1,000
Equipment.....	450	600
Traffic.....	50	150
Conducting transportation.....	1,350	1,800
General and miscellaneous.....	450	800
Total.....	\$3,100	\$4,350

These figures of \$3100 to \$4350 for the operating expense of electric interurban railways apply to such as serve normal territories and operate a basic schedule of hourly service.

TAXES

One other important expense which an electric interurban railway has to meet and which is not included in the operating expense, that of taxes, may well be considered at this point. Taxes vary largely on different roads in different states, as illustrated by the statistics in Table VIII.

The variation in taxes per mile of line as indicated is largely due to the fact that the

electric interurban railway is of modern date and no uniform valuation for the assessment of these properties has been established in the various states. The fact that the taxes on electric interurban railways are considerably below those on steam railway lines indicates

TABLE VIII.—SHOWING THE ACTUAL TAXES ASSESSED
ON TEN TYPICAL ELECTRIC INTERURBAN
RAILWAYS

Case	State	Miles of track	Total taxes	Taxes per mile of track
(1)	Indiana.....	58.7	\$11,729	\$199
(2)	Indiana.....	32	3,870	121
(3)	Illinois.....	406	117,147	288
(4)	Illinois.....	160	51,000	318
(5)	Iowa.....	74	9,525	128
(6)	Ohio.....	222	41,312	186
(7)	Ohio.....	41	6,122	149
(8)	New York.....	180	29,289	162
(9)	Connecticut.....	21	7,511	357
(10)	Massachusetts.....	21	2,016	96
Average taxes per mile of track.		.....	.....	\$156
Average on 243,229 miles of steam road in 1911, per mile of line.		.....	.....	448

that the former are likely to have a general upward tendency, until they approximately equal those of the steam railways. As a

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general conclusion it may be stated that taxes on electric interurban railways will be increased, and that \$250 per mile of track per year is the minimum amount that can be safely used for estimating this item.

CHAPTER V

COST OF CONSTRUCTION

THUS far we have covered the salient points in connection with the operating revenues and operating expense of existing electric interurban railways and deduced the general principles underlying this operating feature for a proposed electric interurban railway. But the promoter and investor desire to know about more than operating revenues and operating expense. They are also highly concerned in the subject of cost of construction, and we shall now take up this other division of our subject and endeavor to give general estimates that may be of value to a proposed electric interurban railway builder or investor.

CLASSIFICATION OF CONSTRUCTION COSTS

Expenditures for the road and equipment of electric railways, as prescribed by the Inter-

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state Commerce Commission in accordance with Section 20 of an act to regulate commerce, fall under three main heads:

I. Road.

II. Equipment.

III. General expenditures.

Each of these general headings is divided by the commission into detailed primary accounts, as follows:

Primary accounts:

I. Road:

- (1) Engineering and superintendence.
- (2) Right-of-way.
- (3) Other land used in electric railway operation.
- (4) Grading.
- (5) Ballast.
- (6) Ties.
- (7) Rails, rail fastenings and joints.
- (8) Special work.
- (9) Underground construction.
- (10) Paving.
- (11) Track laying and surfacing.
- (12) Roadway tools.
- (13) Tunnels.
- (14) Elevated structures and foundations.

- (15) Bridges, trestles and culverts.
- (16) Crossings, fences, cattle guards and signs.
- (17) Interlocking and other signal apparatus.
- (18) Telegraph and telephone lines.
- (19) Poles and fixtures.
- (20) Underground conduits.
- (21) Transmission system.
- (22) Distribution system.
- (23) Dams, canals and pipe lines.
- (24) Power-plant buildings.
- (25) Substation buildings.
- (26) General office buildings.
- (27) Shops and carhouses.
- (28) Stations, waiting rooms and miscellaneous buildings.
- (29) Docks and wharves.
- (30) Power-plant equipment.
- (31) Substation equipment.
- (32) Shop equipment.
- (33) Park and resort property.
- (34) Cost of road purchased.

II. Equipment:

- (35) Cars.
- (36) Locomotives.
- (37) Electric equipment of cars.

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(38) Other rail equipment.

(39) Miscellaneous equipment.

III. General expenditures:

(40) Law expenses.

(41) Interest.

(42) Injuries and damages.

(43) Taxes.

(44) Miscellaneous.

It is obvious that no fixed rule may be laid down for the amount of money to be expended by a proposed electric interurban railway for any of the above items, and they are so numerous and the outlays of the existing companies for them so varied that we shall not take the space here for the detail work leading up to our generalizations. Suffice it to say that as a result of careful study of the cost of construction of existing roads we have arrived at maximum and minimum expenditures for each item that fairly approximate the limits of outlay of a proposed electric interurban railway under average conditions. Taking up each primary account, therefore, under the number given it in the above classification, we shall state only what it covers and our estimated limits of expenditure for it.

PRIMARY ACCOUNTS FOR ROAD CONSTRUCTION

What each primary account under the first main heading of road construction includes and what a promoter may figure on expending therefor is shown by the following:

(1) ENGINEERING AND SUPERINTENDENCE:

This account covers expenditures for services of engineers, draftsmen, superintendents employed on preliminary and construction work and all expenses incidental to the work. This item will run approximately 5 per cent of the cost of the work and will vary between \$1000 and \$2000 per mile of single track.

(2) RIGHT-OF-WAY:

This includes the cost of land acquired for roadbed and all expenses incidental thereto, such as cost of condemnation proceedings, abutting property damages, etc. The cost of procuring right-of-way is entirely dependent on local conditions, and no set rule can be established. The right-of-way will measure 2 acres per mile for each rod in width and a well-constructed line should be 4 to 5 rods in

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width, making a total of from 8 to 10 acres per mile. It may be roughly estimated that the acreage cost of right-of-way will be twice the prevailing acreage price of the adjacent land. On a line constructed through a farming country in which the land is worth \$100 an acre, therefore, the right-of-way will probably cost \$200 an acre, or \$2000 per mile, for 5 rods in width.

(3) OTHER LAND USED IN ELECTRIC RAILWAY OPERATIONS:

This covers the cost of land acquired for use in operating the road other than for roadbed purposes. In general, this item of cost is small and is made up almost wholly of the cost of the ground for power-house and carhouse purposes. It may be roughly estimated at from \$100 to \$500 per mile of track.

(4) GRADING:

The cost of grading the roadbed and all things incidental to the making of the roadbed, such as retaining walls, rip-rap, ditches for waterway, etc., comes under this heading. The amount of grading is entirely dependent

upon the topography of the country traversed and the maximum gradient under which the line is built. For a well-constructed line it may be generally estimated that the grading will vary between 10,000 cu. yd. and 20,000 cu. yd. per mile, at an average cost of from 25 cents to 30 cents per cubic yard, making the approximate limits \$2500 and \$6000 per mile of track.

(5) BALLAST:

Ballast includes the cost of material used and the expenses of loading, hauling, transporting and unloading along the track. The ballast used will vary from 2000 cu. yd. to 3000 cu. yd. per mile, and the cost will vary, with the availability of the material, from 75 cents to \$1.50 per cubic yard, making the approximate cost per mile of track vary between \$1500 and \$4500.

(6) TIES:

This heading includes the cost of cross, switch, bridge and other ties, and the cost of transportation, inspection, handling, and preservation, but not the final distribution. Ties

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will run approximately 2600 to the mile, and will vary in cost from 70 cents to \$1, making the cost from \$1820 to \$2600 per mile.

(7) RAILS, RAIL FASTENINGS AND JOINTS:

This is similar to the above, covering the cost of rails, rail fastenings and joints, and transportation, inspection and handling, but not the final distribution. The quantity will vary with the weight of the rail used. An 80-lb. rail weighs 126 tons per mile, and a 70-lb. rail weighs 110 tons per mile. The price of the rail will be about \$30 per ton. The cost of rail fastenings and joints will be about 11 per cent. of the cost of the rail, so that the cost per mile for a 70-lb. rail, with fastenings and joints, will be approximately \$3700 and for an 80-lb. rail approximately \$4200.

(8) SPECIAL WORK:

By this is meant the cost of steam and street railway crossings, switches, turn-outs, etc., including transportation, inspection and handling, but not the final distribution. The special work expense will vary with local con-

ditions but will usually be between \$400 and \$600 per mile of track.

(9) UNDERGROUND CONSTRUCTION:

This refers only to railways operated by underground electric contacts and therefore does not apply to electric interurban railways.

(10) PAVING:

This embraces the cost of labor and material for paving between rails and the outside thereof, as may be required by city ordinances. As electric interurban railways generally operate over leased tracks into cities with paved streets, this item does not usually enter into the cost of constructing roads. If it does enter into the construction expense, the expense will vary in proportion to the amount of paving required.

(11) TRACK LAYING AND SURFACING:

The cost of distributing the track materials and of constructing the track, together with the cost of spreading the ballast and placing it under the track, are all included herein. This cost will vary from \$800 to \$1200 per mile of track.

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(12) ROADWAY TOOLS:

This heading covers the cost of the first outfit of tools necessary to equip the maintenance of way and structures gangs for properly maintaining and repairing the property when it is opened for the handling of commercial traffic. It may be roughly estimated at \$50 per mile.

(13) TUNNELS:

The cost of tunneling, material used and labor expended in the construction of tunnels are factors in this account. As tunnels are rare on electric interurban railways, however, this item will not be further considered.

(14) ELEVATED STRUCTURES AND FOUNDATIONS:

This refers only to companies operating elevated railway systems and does not apply to electric interurban railways.

(15) BRIDGES, TRETTLES AND CULVERTS:

These items include the cost of materials used and labor expended in the construction of bridges and trestles, both substructure and superstructure, erected to carry tracks over

streams, ravines or the tracks of other railways, and of culverts. The expenditure here depends absolutely upon the local conditions and will show a great variation on different roads. For the general purpose of showing the approximate cost to electric interurban railways, it may be assumed to vary between \$2000 and \$4000 per mile of track.

(16) CROSSINGS, FENCES, CATTLE GUARDS AND SIGNS:

This account contains the cost of material used and labor expended in constructing street, road and farm crossings at grade, overhead bridges, viaducts, fences, cattle guards, etc. The cost may be roughly stated as varying between \$500 and \$1000 per mile.

(17) INTERLOCKING AND OTHER SIGNAL APPARATUS:

This heading covers the cost of material used and labor expended in constructing interlocking and other signal apparatus, complete. The outlay per mile will depend entirely upon the amount of signaling installed. As most roads have been constructed without the

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installation of any signal system, however, the cost may be said to vary from a nominal sum to \$2500 per mile.

(18) TELEGRAPH AND TELEPHONE LINES:

By this heading is meant the cost of material used and labor expended in constructing telegraph and telephone lines, for use in dispatching and other business of the railway. This item will vary in cost from \$100 to \$500 per mile.

(19) POLES AND FIXTURES:

This account contains the cost of poles, cross-arms, insulating pins, brackets and other pole fixtures, also other structures for supporting overhead transmission lines, and all labor expended in connection with the construction of pole lines or structures. These items will vary from \$500 to \$1500 per mile in cost.

(20) UNDERGROUND CONDUITS:

This embraces the cost of material and labor expended in constructing conduits required for underground wires and cables. It does not usually enter into the construction of

electric interurban railways and therefore will not be considered as a probable cost of construction.

(21) TRANSMISSION SYSTEM:

The transmission system account is composed of the cost of the high-tension transmission system, including cables, wires, insulators and insulating material. The cost will vary between \$500 and \$1200 per mile of track.

(22) DISTRIBUTION SYSTEM:

Here is included the cost of material used and labor expended in constructing the distributing system for transmission of low-tension power, including insulators and connections; track bonding and all labor incidental to the same; overhead trolley lines, including cost of trolley, guard, span, strain and other wires; the cost of the third rail and all materials used and labor expended incidental to laying the third rail. The expenditure in this case will vary from \$1500 per mile (in the case of overhead lines) to \$5000 per mile for the third rail.

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(23) DAMS, CANALS AND PIPE LINES:

This has reference primarily to dams and canals, etc., for the utilization of water power, which, not being a usual feature in the construction of electric interurban railways, will not be further considered.

(24) POWER-PLANT BUILDINGS:

This covers the cost of material used and labor expended in erecting buildings to be used for power-generating plants, as well as the excavations, gas and water-pipe connections, etc., incidental thereto. The cost here will vary between \$15 and \$20 per kilowatt of station capacity, which capacity will range from 40 kw. to 60 kw. per mile of track, making the cost of the power-house buildings from \$600 to \$1200 per mile of track.

(25) SUBSTATION BUILDINGS:

This caption embraces the cost of material used and labor expended in erecting buildings for use as power substations. The cost will range between \$300 and \$500 per mile of track.

(26) GENERAL OFFICE BUILDINGS:

As it is unusual for electric interurban railways to own a general office building in fee, this cost will be eliminated from this discussion.

(27) SHOPS AND CARHOUSES:

The cost of material used and labor expended on buildings to be used as shops, sheds or carhouses, and on plants for furnishing power for heating and lighting, is included in this account, as well as the cost of construction of oil houses, sand houses and storehouses. This outlay will vary between \$400 and \$600 per mile of track.

(28) STATIONS, WAITING ROOMS AND MISCELLANEOUS BUILDINGS:

This covers the cost of material used and labor expended in the erection of stations, waiting rooms and other buildings not heretofore classified. It includes also the furniture and fixtures used to complete these buildings. This cost will run from \$100 to \$200 per mile of track.

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(29) DOCKS AND WHARVES:

As this item is not usual in electric interurban railway construction, it will not be considered further.

(30) POWER-PLANT EQUIPMENT:

By this heading is meant the cost of material and labor expended in equipping plants for generating power; the cost of engines, boilers, pumps, condensers and all equipment for generating electric current, and also the cost of foundations for any of the foregoing equipment, switchboards and all fixtures and appliances connected therewith. This item of cost will vary between \$50 and \$75 per kilowatt of capacity, and as the power requirements will vary from 40 kw. to 60 kw. per mile of track, the cost will be between \$2000 and \$4500 per mile of track.

(31) SUBSTATION EQUIPMENT:

Here is embraced the cost of material used and labor expended in equipping power substations and the cost of storage batteries, transformers, rotary converters, switchboard

and foundations therefor. The outlay will vary between \$750 and \$1500 per mile of track.

(32) SHOP EQUIPMENT:

This includes the cost of machinery and tools used in shops and carhouses, including also boilers, engines, motors and all appliances and tools first necessary to equip the shops. The estimated expenditure for this account is from \$150 to \$300 per mile of track.

(33) PARK AND RESORT PROPERTY:

The cost of property for amusement parks or resorts is herein provided for. As this is not an essential to the construction of an electric interurban railway, it will not be considered in this discussion.

(34) COST OF ROAD PURCHASED:

For obvious reasons this item will also be eliminated from this discussion.

PRIMARY ACCOUNTS FOR COST OF
EQUIPMENT

Following out the same plan as given for the cost of road construction, we find that the in-

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formation concerning the primary cost of equipment accounts may be classified as follows:

(35) CARS:

This account covers all expenditures for passenger, baggage, express, freight, mail and other cars, from the operation of which revenue is to be derived, and the car bodies, trucks, and all fixtures or appliances inside of, or attached to, the car bodies or trucks except the electric equipment of the cars. Electric interurban railways require from one car for every 5 miles operated to one car for every 3 miles operated. Cars will vary in cost from \$4000 to \$8000, and therefore the cost of this item will be between \$800 a mile and \$2600 a mile.

(36) LOCOMOTIVES:

This means all expenditures for locomotives, including all appurtenances, furniture, fixtures and electric equipment, necessary to fit them for service. As locomotives are not essential to the service rendered by an electric interurban railway, this item will not be considered as a necessary construction cost.

(37) ELECTRIC EQUIPMENT OF CARS:

This includes all expenditures for electrical equipment and wiring of all cars of whatsoever nature. The outlay for this will vary from \$3000 to \$5000 per car and from \$600 to \$1600 per mile of track.

(38) OTHER RAIL EQUIPMENT:

Herein are grouped all expenditures for water cars, sprinkling cars, sand cars, salt cars, supply cars, and other work cars; also snow plows, sweepers and scrapers. This cost will vary between \$200 and \$500 per mile.

(39) MISCELLANEOUS EQUIPMENT:

This account contains all expenditures for horses, wagons, harness, automobiles and other road equipment. As the expenditures under this item are relatively small, the cost is considered negligible and is therefore eliminated.

PRIMARY ACCOUNTS FOR GENERAL CONSTRUCTION EXPENDITURES

The various primary accounts prescribed by the Interstate Commerce Commission for general expenditures in connection with con-

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struction are as follows, with our estimate of cost for each item:

(40) LAW EXPENSES:

By these are meant expenditures for counsel, solicitors and attorneys, their clerks and attendants and expenses of their offices, together with all incidental legal expenses during the construction of the road. This cost will run from \$200 to \$500 per mile of track.

(41) INTEREST:

This includes the interest on the moneys used incidental to, and during the period of, construction but does not include discounts and commissions on securities issued for construction purposes. This will vary from \$1000 to \$2000 per mile of track.

(42) INJURIES AND DAMAGES:

This account covers all expenses incidental to injuries to persons or damages to property caused directly in connection with the construction of the road and equipment. The expenditure necessitated here will lie between \$100 and \$200 per mile of track.

(43) TAXES:

This embraces all taxes and assessments levied and paid on the company's property while under construction. This outlay usually amounts to very little and is estimated at from \$50 to \$100 per mile of track.

(44) MISCELLANEOUS:

Under this caption are grouped all organization expenses, including the payment of all organization fees, the cost of preparing certificates of stocks and bonds, the payment of trustees' fees, expenses incurred in the disposal of securities, salaries and expenses of executive and general officers of a road under construction and general office clerks, rent of office space, and all items of special and incidental nature which cannot properly be charged to any other account in this classification. The cost here will vary from \$500 to \$1000 per mile of track.

SUMMARY OF CONSTRUCTION COSTS

In the above discussion we have taken up one by one the primary road, equipment and miscellaneous construction accounts and given

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for each one what we deemed to be fair maximum and minimum limits of expenditure for a proposed electric interurban railway under average conditions. It might be to the reader's advantage now briefly to summarize these estimates in table form, in order that he may see at a glance their sum total and relative weights. This information is accordingly presented in Table IX.

TABLE IX.—SHOWING A SUMMARY OF THE PRIMARY CONSTRUCTION COSTS PREVIOUSLY CITED FOR A PROPOSED ELECTRIC INTERURBAN RAILWAY

Accounts	Cost per mile of track	
	Minimum	Maximum
(1) Engineering and superintendence.	\$1,000	\$2,000
(2) Right-of-way.....	2,000	4,000
(3) Other land used in electric railway operations.	100	500
(4) Grading.....	2,500	6,000
(5) Ballast.....	1,500	4,500
(6) Ties.....	1,820	2,600
(7) Rails, rail fastenings and joints	3,700	4,200
(8) Special work.....	400	600
(9) Underground construction.....		
(10) Paving.....		
(11) Track laying and surfacing....	800	1,200
(12) Roadway tools.....	50	50
(13) Tunnels.....		
(14) Elevated structures and foundations.		

Accounts	Cost per mile of track	
	Minimum	Maximum
(15) Bridges, trestles and culverts..	2,000	4,000
(16) Crossings, fences, cattle guards and signs.	500	1,000
(17) Interlocking and other signal apparatus.	.....	2,500
(18) Telegraph and telephone lines.	100	500
(19) Poles and fixtures.....	500	1,500
(20) Underground conduits.....	.....	.....
(21) Transmission system.....	500	1,200
(22) Distribution system.....	1,500	5,000
(23) Dams, canals and pipe lines...	.....	.....
(24) Power-plant buildings.....	600	1,200
(25) Substation buildings.....	300	500
(26) General office buildings.....	.....	.....
(27) Shops and carhouses.....	400	600
(28) Stations, waiting rooms and miscellaneous buildings.	100	200
(29) Docks and wharves.....	.....	.....
(30) Power-plant equipment.....	2,000	4,500
(31) Substation equipment.....	750	1,500
(32) Shop equipment.....	150	300
(33) Park and resort property.....	.....	.....
(34) Cost of road purchased.....	.....	.....
(35) Cars.....	800	2,600
(36) Locomotives.....	.....	.....
(37) Electric equipment of cars....	600	1,600
(38) Other rail equipment.....	200	500
(39) Miscellaneous equipment.....	.....	.....
(40) Law expenses.....	200	500
(41) Interest.....	1,000	2,000
(42) Injuries and damages.....	100	200
(43) Taxes.....	50	100
(44) Miscellaneous.....	500	1,000
Total.....	\$26,720	\$58,650

GENERAL CONCLUSIONS CONCERNING
COST OF CONSTRUCTION

The summary in the above table shows that the probable limits of cost for the construction of electric interurban railways are \$26,720 and \$38,650. These figures clearly indicate the possible wide variation of such expenditures. The approximate average cost of constructing existing electric interurban railways that are in the category of what are herein called normal electric interurban railways was about \$35,000 per mile. It is true, on the other hand, that there are a number of roads, also qualifying in many respects as normal roads, which cost less than the minimum shown in the summary in Table IX, due perhaps to the lack of sufficient car equipment, of power-plant buildings or equipment, or of any other elements of construction. Such a low construction cost might all be caused by the company having been subsidized by monetary subscriptions, free right-of-way or other benefits. At any rate, the figures for the average case are those given above, and they should prove enlightening to those who are laboring under the erroneous impression

that electric interurban railways can be built for insignificant amounts.

We have endeavored thus far to obtain by a study of existing electric interurban railways general figures for construction costs that will be of value to the layman interested in such projects. These figures are not definite, however; they cannot be, for it is difficult to give even an approximate statement with regard to the cost of building a proposed line unless a full knowledge has been obtained of the constructional elements entering therein and of the requirements for power and car equipment. As in the case of determining operating revenue, it would be best to leave it to a competent expert, of good judgment, to estimate this cost of construction, yet we believe that if the layman makes a proper study of conditions surrounding the projected enterprise, he will be aided in judging its worth by a reference to Table IX to find out the maximum and minimum limits for normal roads fully equipped with the necessary power stations and cars and operating in normal territory. He must distinctly bear in mind, however, that none of these conclusions refers to abnormal lines serv-

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ing abnormal territory. In fact, many short electric roads have been constructed with light rail and equipment for astonishingly low costs, but usually the advantage of the low cost of construction has been offset by the high cost of operation.

CHAPTER VI

ECONOMIC RELATIONS. OPERATING REVENUES, OPERATING EXPENSES, AND COST OF CONSTRUCTION

THE prevailing rates of interest, demanded by the investing public, on the securities of electric interurban railways, range from 6 per cent. to 7 per cent., which high rates have been largely brought about by the construction of so many unprofitable roads through ignorance of the fundamentally essential elements entering into such an undertaking. In order to borrow from the investing public the necessary funds with which to construct an interurban railway, the project must show an earning power of a net revenue, after paying operating expenses and taxes, of from one and one-half to two times the amount of the interest on the construction cost, to be computed on a basis of from 6 per cent. to 7 per cent.

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HYPOTHETICAL APPLICATION OF THE HERETO- FORE ESTABLISHED PRINCIPLES GOVERNING OPERATING REVENUES, OPERATING EXPENSES, CONSTRUCTION COSTS

CASE 1

Under Case 1 it is proposed to construct a normal road from a primary terminal city of 50,000 population through a normal territory to a town of 5000 population 10 miles distant, thence to another town of the same population also 10 miles distant, and thence to a third similar town 10 miles distant. This line will be 30 miles long and will have an intermediate town and village population of 15,000, with no secondary terminal. Under such conditions, as determined in the first article, the earnings from Source I are approximately \$10 per capita of intermediate town and village population, or a total of \$150,000 per annum.

On the basis of the conclusions reached in Chapter IV, because this hypothetical road is short, we estimate the operating expense at the minimum determined for normal roads, or \$3100 per mile of track per year, which

aggregates \$93,000 per year. The taxes will be approximately the minimum of \$250 per mile of track, or \$7500 per year. The cost of construction will also be approximately the minimum of the limits heretofore determined, or \$26,550 per mile, which is a total of \$801,600.

The surplus earnings, after deducting the operating expenses and taxes, will be \$49,500. The interest on the cost of construction, at 6 1/2 per cent. per annum, will amount to \$52,104. This road will therefore fail to earn its interest by \$2604 and will fall short of making its securities negotiable by approximately \$50,000. The project, therefore, fails as an economic success.

SUMMARY FOR CASE 1

The following summary may be of value in showing in statement form how the deficit in Case 1 is arrived at:

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TABLE I.—SHOWING APPLICATION OF PRINCIPLES HERETOFORE DEDUCED TO
HYPOTHETICAL CASE 1

Operating revenue—15,000 intermediate town and village population, at \$10 per capita.....	\$150,000
Operating expense—30 miles, at \$3100 per mile per year.....	93,000
Net revenue.....	\$57,000
Taxes—30 miles, at \$250 per mile.....	7,500
Surplus applicable to fixed charges.....	49,500
Interest on \$801,600, at 6 1/2 per cent.....	52,104
Deficit.....	\$2,604

MODIFICATION OF CASE 1

If we estimate that the total intermediate town and village population is 18,000 instead of 15,000, the results for Case 1 will be modified as indicated in Table II on the following page.

It will be observed that the surplus earnings, after deductions for operating expense and taxes, will approximately equal one and one-half times the interest charges computed on the basis of 6 1/2 per cent. of the cost of construction. The intermediate town and village population of this hypothetical road is 600 per mile of track. It may therefore be concluded,

in a general way, that such a projected road, serving a primary terminal and intermediate town and village population only, should have not less than an average of 600 of intermediate town and village population per mile of track.

Inasmuch, however, as the above operating expense and cost of construction were computed at the minimum of the deductions heretofore made, it is apparent that should the elements of construction or operation indicate costs higher than the minimum, a proportionately greater intermediate town and village population per mile of track must prevail to make such a road a financial success.

TABLE II.—SHOWING APPLICATION OF PRINCIPLES HERETOFORE DEDUCED TO HYPOTHETICAL CASE 1 AS MODIFIED

Operating revenue—18,000 intermediate town and village population, at \$10 per capita.....	\$180,000
Operating expense—30 miles, at \$3100 per mile per annum.....	93,000
Net revenue.....	\$87,000
Taxes—30 miles, at \$250 per mile.....	7,500
Surplus applicable to fixed charges.....	\$79,500
Interest on \$801,600, at 6 1/2 per cent.....	52,104
Surplus applicable to dividends.....	\$27,396

CASE 2

In Case 1 we had a normal road 30 miles long serving only a primary terminal of 50,000 population and an intermediate town and village population of from 15,000 to 18,000. In this case, however, the road will be extended 10 miles farther to a city with a population of 20,000, qualifying as a secondary terminal (Source II). The intermediate town and village population (Source I) will be 15,000. The total miles of track will be 40 and the distance between terminals 40 miles.

As in the preceding case, the revenue from Source I will be \$10 per capita of intermediate town and village population, or \$150,000 per annum. In obtaining the revenue from Source II, the character of the terminals may be taken into consideration, for the conditions conducive to intercommunication between the primary and secondary terminals will have a bearing on the revenue. It is here estimated that the primary terminal is the capital of a state and the secondary terminal is the county seat of the adjacent county. In this instance there is the average cause for intercommunication, and the

average earnings under these conditions can be properly estimated, viz., \$8 per capita of secondary terminal population, which gives a total from Source II of \$160,000.

SUMMARY OF CASE 2

The complete compilation of operating results for Case 2 is as follows:

TABLE III.—SHOWING APPLICATION OF PRINCIPLES HERETOFORE DEDUCED TO HYPOTHETICAL CASE 2

Revenue from Source I—	
15,000 intermediate town and village population, at \$10 per capita.....	\$150,000
Revenue from Source II—	
20,000 secondary terminal population, at \$8 per capita.....	160,000
	<hr/>
Total gross revenue.....	\$310,000
Operating expenses—	
40 miles, at \$4350 per mile.....	174,000
	<hr/>
Net earnings.....	\$136,000
Taxes—40 miles, at \$250 per mile.....	10,000
	<hr/>
Net earnings applicable to fixed charges.....	\$126,000
Interest on construction cost, \$1,440,000, at 6 1/2 per cent.....	86,400
	<hr/>
Surplus earnings applicable to dividends.....	\$39,600

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The conditions of service in the above instance entailed a greater number of car movements than in Case 1, and the operating expenses were approximately the maximum of those deduced in Chapter IV, viz., \$4350 per mile of track, or a total of \$174,000 per annum. The construction cost in this case would also be higher than in Case 1 and was estimated at \$35,000 per mile, or \$1,440,000 for 40 miles.

This road would fall a little short of producing such economic results as would qualify it as a commercially feasible project, but if the population of the secondary terminal were 22,000 it would just about so qualify.

MODIFICATIONS OF CASE 2

If the primary terminal were merely the county seat of one county and the secondary terminal the county seat of the adjacent county, it is not believed that the revenue from Source II could be safely estimated as high as \$8 per capita. If, on the other hand, the primary terminal were a city of 1,000,000 population and therefore exercised a predominating commercial influence over the second-

ary terminal, the estimate of earnings due to Source II might be increased to \$15, and in the extreme cases to \$20, per capita of secondary terminal population. Again, if the secondary terminal population were removed a greater distance from the primary terminal, the intercommunication would be reduced, and a reduction of the revenues from Source II should be made to the extent of approximately \$1 per capita for every 10 miles of increased distance between the terminals.

CASE 3

In the preceding case there was a 40-mile normal electric interurban railway with a primary terminal of 50,000 population, an intermediate town and village population of 15,000 and a secondary terminal population of 20,000. In Case 3 these conditions will still obtain, with the exception that there will be a further 10-mile extension of the line to a town of 5000 population and another 10-mile extension to a city of 20,000 population of sufficient importance to be classed as an additional secondary terminal, and the intermediate town and village

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TABLE IV.—SHOWING APPLICATION OF
PRINCIPLES HERETOFORE DEDUCED
TO HYPOTHETICAL CASE 3

Revenue from Source I—	
20,000 population, at \$10 per capita.....	\$200,000
Revenue from Source II—	
First, the population of the first secondary terminal, viz., 20,000, at \$8 per capita.....	160,000
Second, the population of the second secondary terminal, viz., 20,000, at \$7 per capita.....	140,000
	<hr/>
Total gross revenue.....	\$500,000
Operating expenses—	
60 miles, at \$4350 per mile.....	261,000
	<hr/>
Net earnings applicable to taxes and fixed charges.....	\$239,000
Taxes—60 miles, at \$250 per mile.....	15,000
	<hr/>
Net earnings applicable to fixed charges.....	\$224,000
Interest on construction, \$35,000 per mile, or \$2,100,000, at 6 1/2 per cent.....	136,500
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Surplus earnings applicable to dividends.....	\$87,500

population will be increased to 20,000. The primary terminal is 40 miles distant from the first secondary terminal and 60 miles from the second primary terminal, and the secondary terminals are 20 miles distant from each other.

The revenue from Source I, on the \$10 per

capita of intermediate town and village population basis heretofore used, will be \$200,000 per annum.

As to the revenue from Source II, we have the following items: First, the return from the population of the first secondary terminal, viz., 20,000, at \$8 per capita, or a total of \$160,000; second, the return from the population of the second secondary terminal. This latter terminal, being 60 miles from the primary terminal, will be entitled to an estimate of approximately \$6 per capita from the viewpoint of its relations with the primary terminal; and being 20 miles from the first secondary terminal, it will be entitled to an estimate of \$8 per capita, an average of \$7 per capita for the 20,000 population, or a total of \$140,000.

The operating expenses are on the basis of \$4350 for each of the 60 miles of track. The cost of construction is \$35,000 per mile, as in the previous instance, or a total of \$2,100,000.

The résumé for Case 3 as given in Table IV on the preceding page shows surplus earnings applicable to dividends of \$87,500, which indicates that this hypothetical road is a financially feasible project.

MODIFICATION OF CASE 3

The judgment of the expert must be carefully exercised in determining the intercommunication between the primary and secondary terminals and between the two secondary terminals. The same general reasoning should be followed as in the modification of Case 2. If the second secondary terminal is a city of 40,000 inhabitants, then it will be far less dependent on the primary terminal, and the intercommunication between these terminals will be greatly reduced. While, on the other hand, the intercommunication between the two secondary terminals will be increased. In such a case, the value of the first secondary terminal for revenue from Source II should be increased to perhaps \$10 per capita of its population, and the value of the second secondary terminal should be decreased to perhaps \$4 per capita in estimating the revenues from Source II.

Where the above conditions exist, in addition to the revenue changes the cost of construction will also undergo modification. Because of the importance of the second secondary terminal and its influence on the cost of construction of

the road by entering a larger city, the estimate for this case will be \$40,000 per mile of track, or \$2,400,000 for the 60 miles. The complete summary under Case 3 as modified is as follows:

TABLE V.—SHOWING APPLICATION OF PRINCIPLES HERETOFORE DEDUCED TO HYPOTHETICAL CASE 3 AS MODIFIED

Revenue from Source I—	
20,000 population, at \$10 per capita.....	\$200,000
Revenue from Source II—	
First, 20,000 population of first secondary terminal, at \$10 per capita.....	200,000
Second, 40,000 population of second secondary terminal, at \$4 per capita.....	160,000
	<hr/>
Total gross revenue... ..	\$560,000
Operating expense.....	261,000
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Net earnings applicable to taxes and fixed charges.....	\$299,000
Taxes.....	15,000
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Net earnings applicable to fixed charges.....	\$284,000
Interest on construction, \$40,000 per mile, or \$2,400,000, at 6 1/2 per cent.....	156,000
	<hr/>
Surplus applicable to dividends.....	\$128,000

This third hypothetical case represents ideal conditions for an electric interurban project. It indicates in a general way the territory necessary to the production of satisfactory economic results.

CHAPTER VII

CONCLUDING REMARKS

THE foregoing discussion and tables should enable the promoter and investor to see more clearly the economic relations between the operating and construction statistics that we have compiled in the previous chapters, and they should have a better conception of the factors that are necessary for the success of projected electric interurban railways. While the fundamental elements necessary to an economically feasible road have been determined within approximate limits for simply normal roads operating in normal territory, it is believed that the hazard of indiscriminately applying these limits to all cases will be fully realized, and that the necessity of employing expert talent, with mature discriminating judgment, to estimate the probable performances of a projected road is fully appreciated. It is also believed that projected electric interurban

railways that to the intelligent layman do not qualify as economically feasible propositions, under the limits we have set forth, would better be left unconstructed.

From the statements made herein the conclusion may be drawn that a great number of the electric interurban railways now in operation are not the commercial successes they are generally considered to be, and in this conclusion the writer fully concurs. This does not mean that there are not many profitable electric interurban railways, for there are many such; but this only serves to emphasize the fact that it is suicidal to rush into electric interurban construction unless a proper study is made of existing conditions and the factors underlying success. At the present time there are territories susceptible of developing profitable electric interurban railways. As the town and village population continues to increase, there will be many more such, and the promoter and investor who use the principles obtained from experience in a scientific study of a projected line will most surely and most quickly be rewarded by financial success.

